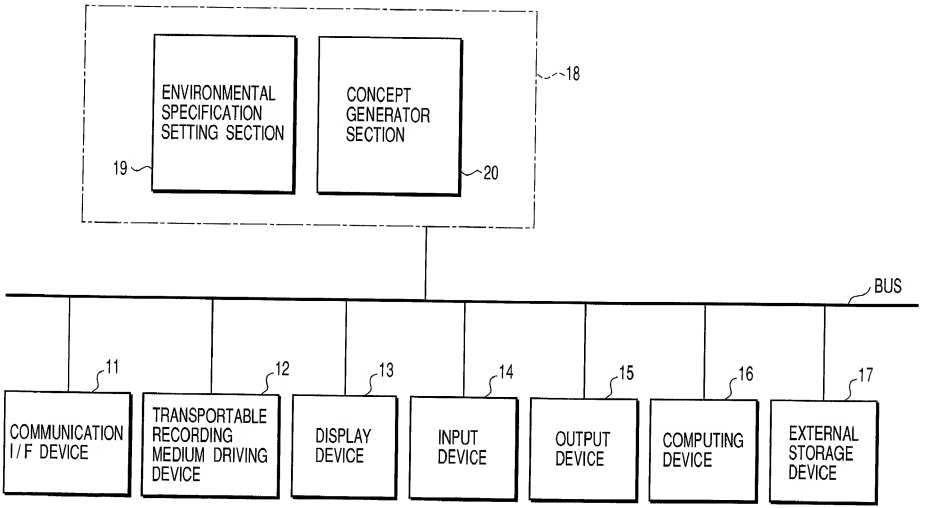

FIG. 1

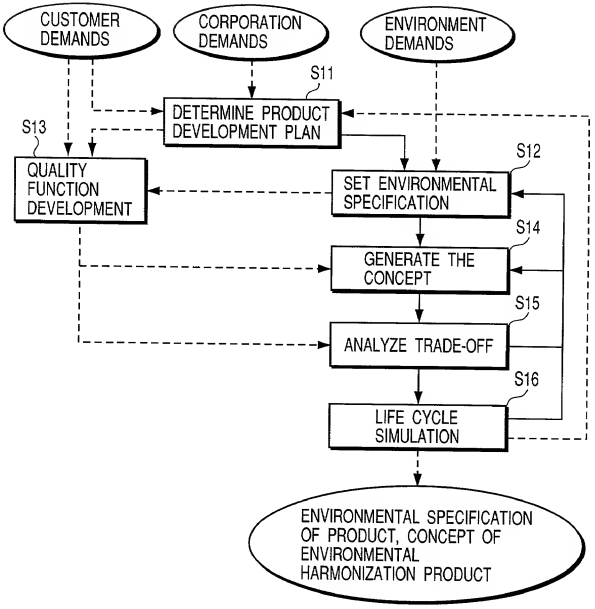
CUSTOMER DEMANDS
CORPORATION DEMANDS
ENVIRONMENT DEMANDS
S11
DETERMINE PRODUCT DEVELOPMENT PLAN
S13
QUALITY FUNCTION DEVELOPMENT
S12
SET ENVIRONMENTAL SPECIFICATION
S14
GENERATE THE CONCEPT
S15
ANALYZE TRADE-OFF
S16
LIFE CYCLE SIMULATION
ENVIRONMENTAL SPECIFICATION OF PRODUCT, CONCEPT OF ENVIRONMENTAL HARMONIZATION PRODUCT

FIG. 2

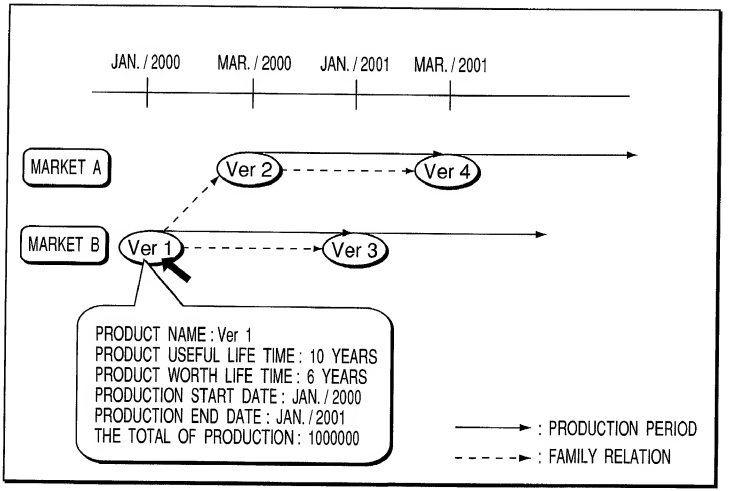

FIG. 3

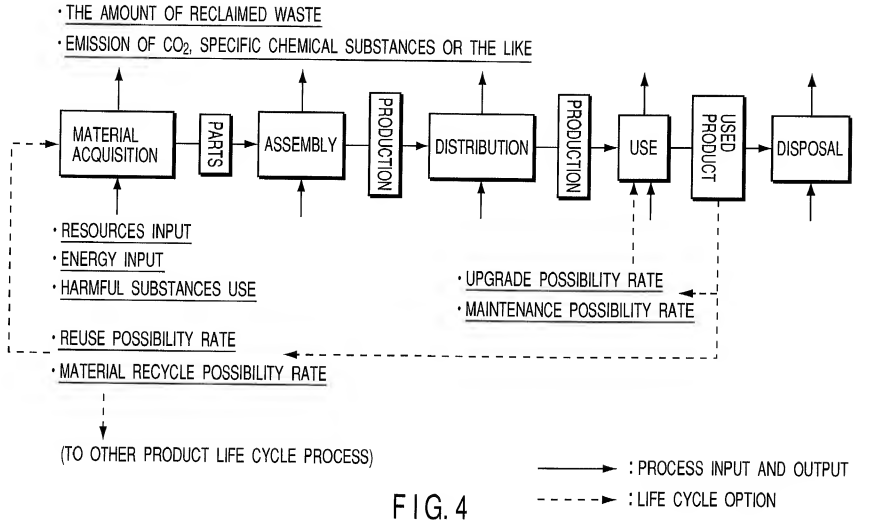

FIG. 4

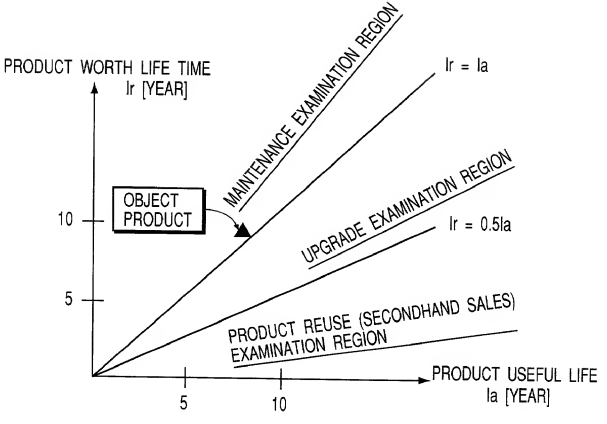
PRODUCT WORTH LIFE TIME
Ir [YEAR]
Ir = Ia
MAINTENANCE EXAMINATION REGION
OBJECT PRODUCT
10
UPGRADE EXAMINATION REGION
Ir = 0.5Ia
5
PRODUCT REUSE (SECONDHAND SALES) EXAMINATION REGION
PRODUCT USEFUL LIFE
Ia [YEAR]
5
10

FIG. 5A

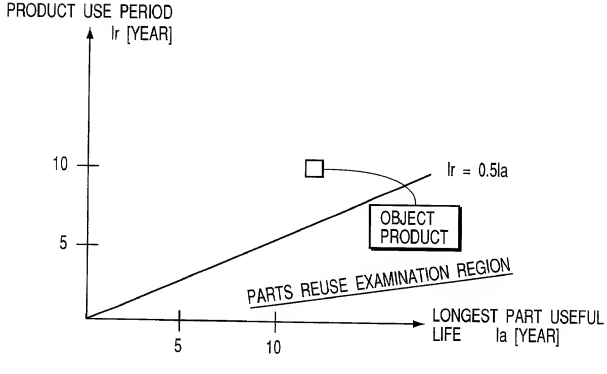
PRODUCT USE PERIOD
Ir [YEAR]
10
Ir = 0.5Ia
OBJECT PRODUCT
5
PARTS REUSE EXAMINATION REGION
LONGEST PART USEFUL LIFE
Ia [YEAR]
5
10

FIG. 5B

SUBJECT CATEGORY	LIFE CYCLE STEPS	ENVIRONMENT DEMANDS	MUST/WANT				ENVIRONMENTAL CHARACTERISTIC	TARGET VALUE			
			Ver 1	Ver 2	Ver 3	Ver 4		Ver 1	Ver 2	Ver 3	Ver 4
SAVING RESOURCES	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION	SIMPLIFICATION OF PACKING									
	USE	WATER USE REDUCTION	W	W	W	W	VOLUME OF WATER PER ONE TIME [L]				40
	DISPOSAL										
SAVING ENERGY	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE	POWER CONSUMPTION REDUCTION									
	DISPOSAL										
WASTE REDUCTION	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE										
	DISPOSAL	RECLAIMED DISPOSITION AMOUNT REDUCTION									

FIG. 6A

HARMFUL SUBSTANCES REDUCTION	MATERIAL ACQUISITION	ADOPTION OF LEAD-FREE SOLDER	W	W	M	M	LEAD USE [g]			0	0
	PRODUCTION										
	DISTRIBUTION										
	USE										
	DISPOSAL										
EMISSION REDUCTION	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE	WATER-POLLUTION REDUCTION									
	DISPOSAL										
LIFE CYCLE OPTION		UPGRADE									
LIFE CYCLE OPTION		MAINTENANCE		W	W	W	MAINTENANCE POSSIBILITY RATE [%]		80	80	90
LIFE CYCLE OPTION		PARTS REUSE		W	W	W	REUSE POSSIBILITY RATE [%]				
LIFE CYCLE OPTION		MATERIAL RECYCLE	M	M	M	M	RECYCLE POSSIBILITY RATE [%]	70	70	70	70

FIG. 6B

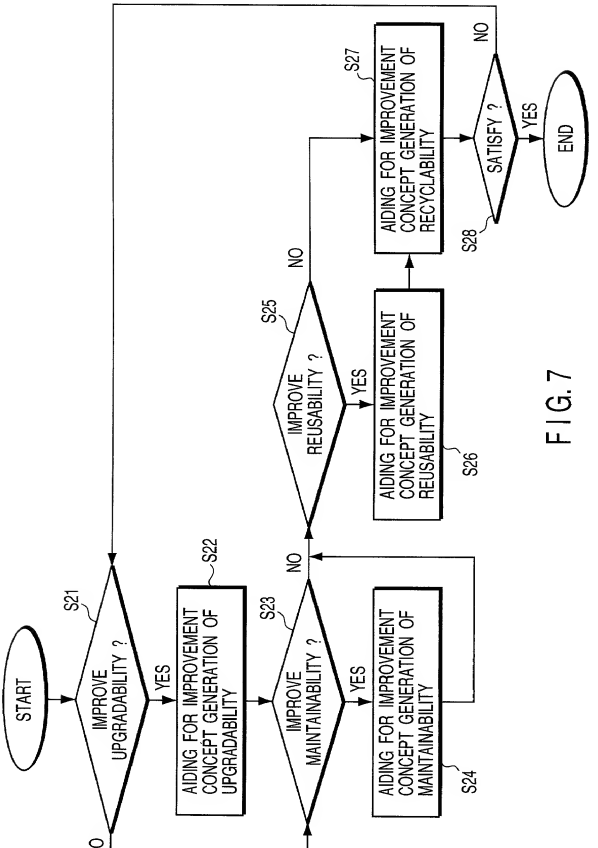
START
IMPROVE UPGRADABILITY ?
S21
YES
NO
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF UPGRADABILITY
S22
IMPROVE MAINTAINABILITY ?
S23
YES
NO
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF MAINTAINABILITY
S24
IMPROVE REUSABILITY ?
S25
YES
NO
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF REUSABILITY
S26
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF RECYCLABILITY
S27
SATISFY ?
S28
YES
NO
END

FIG. 7

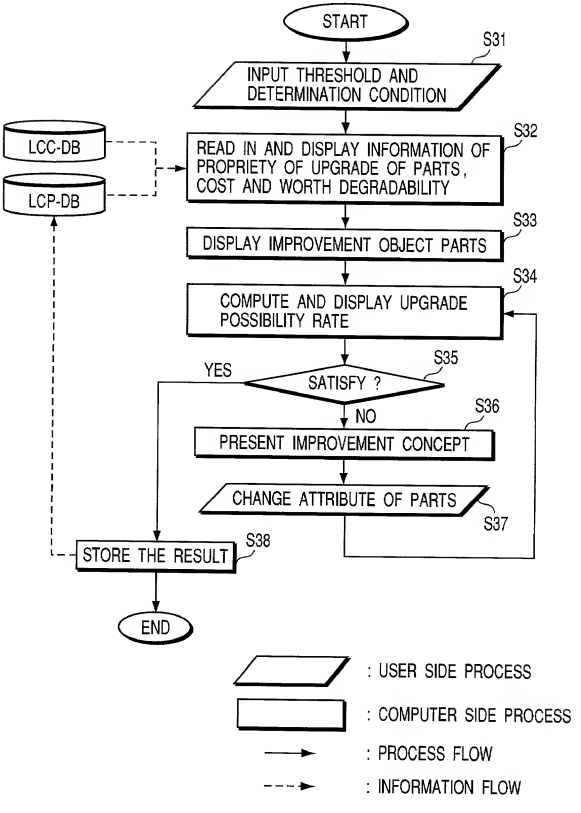
START
S31
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCP-DB
S32
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF UPGRADE OF PARTS, COST AND WORTH DEGRADABILITY
S33
DISPLAY IMPROVEMENT OBJECT PARTS
S34
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
YES
S35
SATISFY ?
NO
S36
PRESENT IMPROVEMENT CONCEPT
CHANGE ATTRIBUTE OF PARTS
S37
S38
STORE THE RESULT
END
: USER SIDE PROCESS
: COMPUTER SIDE PROCESS
: PROCESS FLOW
: INFORMATION FLOW

FIG. 8

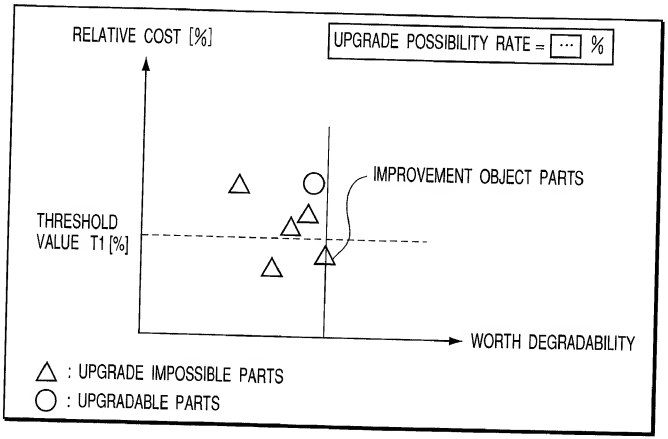

FIG. 9

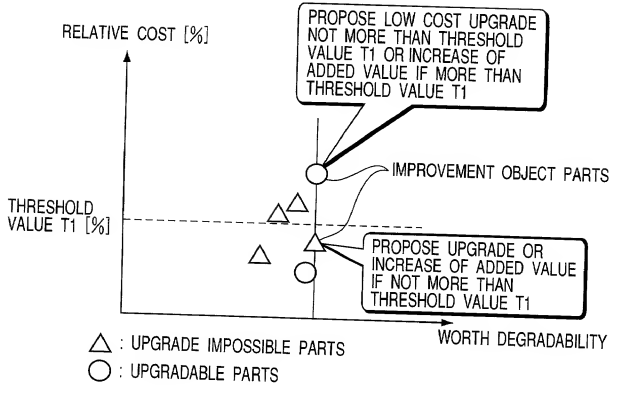
RELATIVE COST [%]
PROPOSE LOW COST UPGRADE NOT MORE THAN THRESHOLD VALUE T1 OR INCREASE OF ADDED VALUE IF MORE THAN THRESHOLD VALUE T1
IMPROVEMENT OBJECT PARTS
THRESHOLD VALUE T1 [%]
PROPOSE UPGRADE OR INCREASE OF ADDED VALUE IF NOT MORE THAN THRESHOLD VALUE T1
WORTH DEGRADABILITY
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 10

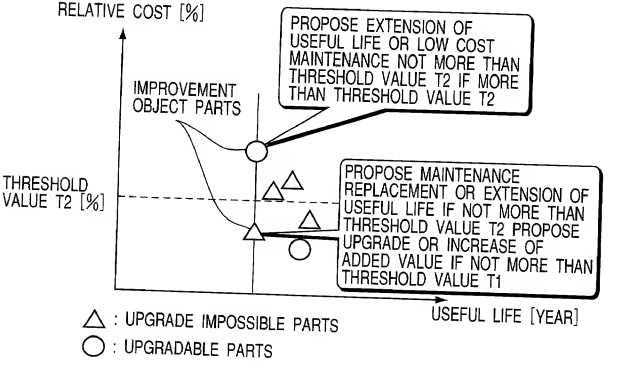
RELATIVE COST [%]
PROPOSE EXTENSION OF USEFUL LIFE OR LOW COST MAINTENANCE NOT MORE THAN THRESHOLD VALUE T2 IF MORE THAN THRESHOLD VALUE T2
IMPROVEMENT OBJECT PARTS
THRESHOLD VALUE T2 [%]
PROPOSE MAINTENANCE REPLACEMENT OR EXTENSION OF USEFUL LIFE IF NOT MORE THAN THRESHOLD VALUE T2 PROPOSE UPGRADE OR INCREASE OF ADDED VALUE IF NOT MORE THAN THRESHOLD VALUE T1
USEFUL LIFE [YEAR]
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 14

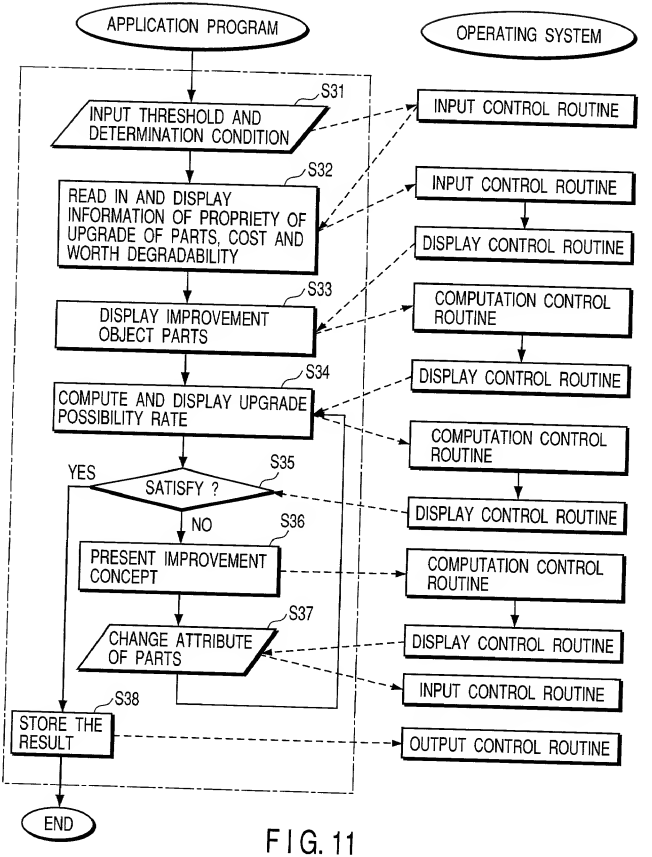
APPLICATION PROGRAM
OPERATING SYSTEM
S31
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S32
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF UPGRADE OF PARTS, COST AND WORTH DEGRADABILITY
INPUT CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S33
DISPLAY IMPROVEMENT OBJECT PARTS
COMPUTATION CONTROL ROUTINE
S34
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
DISPLAY CONTROL ROUTINE
COMPUTATION CONTROL ROUTINE
YES
S35
SATISFY ?
DISPLAY CONTROL ROUTINE
NO
S36
PRESENT IMPROVEMENT CONCEPT
COMPUTATION CONTROL ROUTINE
S37
CHANGE ATTRIBUTE OF PARTS
DISPLAY CONTROL ROUTINE
INPUT CONTROL ROUTINE
S38
STORE THE RESULT
OUTPUT CONTROL ROUTINE
END

FIG. 11

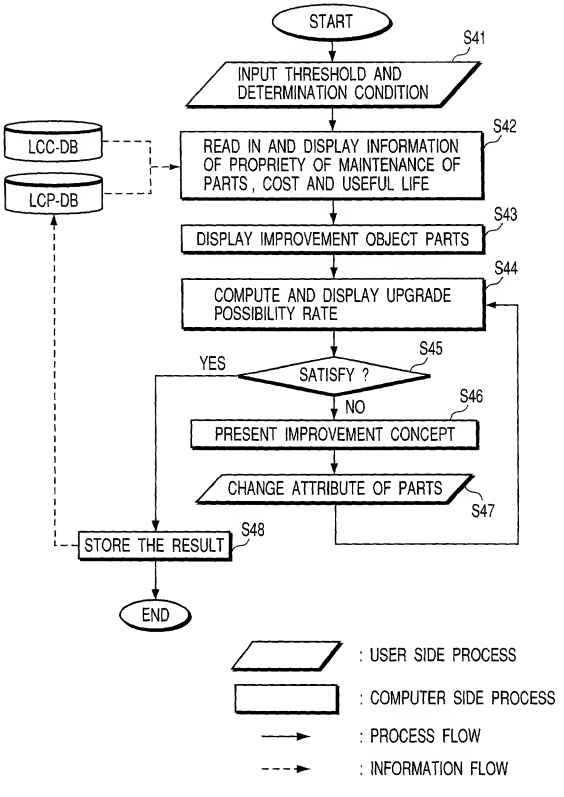
START
S41
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCP-DB
S42
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF MAINTENANCE OF PARTS, COST AND USEFUL LIFE
S43
DISPLAY IMPROVEMENT OBJECT PARTS
S44
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
S45
YES
SATISFY ?
NO
S46
PRESENT IMPROVEMENT CONCEPT
CHANGE ATTRIBUTE OF PARTS
S47
S48
STORE THE RESULT
END
: USER SIDE PROCESS
: COMPUTER SIDE PROCESS
: PROCESS FLOW
: INFORMATION FLOW

FIG. 12

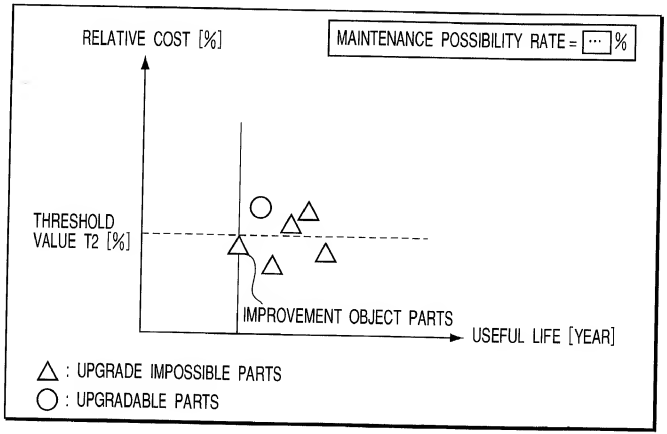

FIG. 13

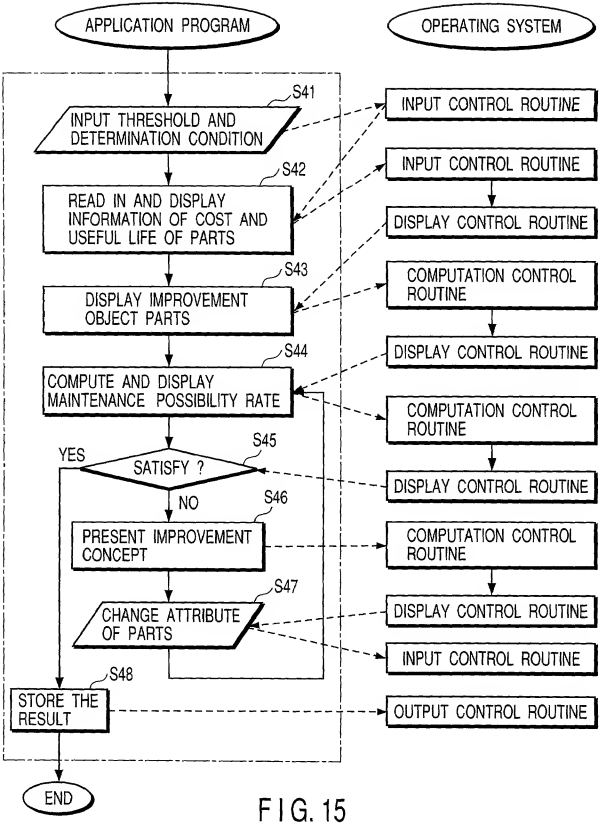
APPLICATION PROGRAM
OPERATING SYSTEM
S41
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S42
READ IN AND DISPLAY INFORMATION OF COST AND USEFUL LIFE OF PARTS
INPUT CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S43
DISPLAY IMPROVEMENT OBJECT PARTS
COMPUTATION CONTROL ROUTINE
S44
COMPUTE AND DISPLAY MAINTENANCE POSSIBILITY RATE
DISPLAY CONTROL ROUTINE
COMPUTATION CONTROL ROUTINE
YES
S45
SATISFY ?
DISPLAY CONTROL ROUTINE
NO
S46
PRESENT IMPROVEMENT CONCEPT
COMPUTATION CONTROL ROUTINE
S47
CHANGE ATTRIBUTE OF PARTS
DISPLAY CONTROL ROUTINE
INPUT CONTROL ROUTINE
S48
STORE THE RESULT
OUTPUT CONTROL ROUTINE
END

FIG. 15

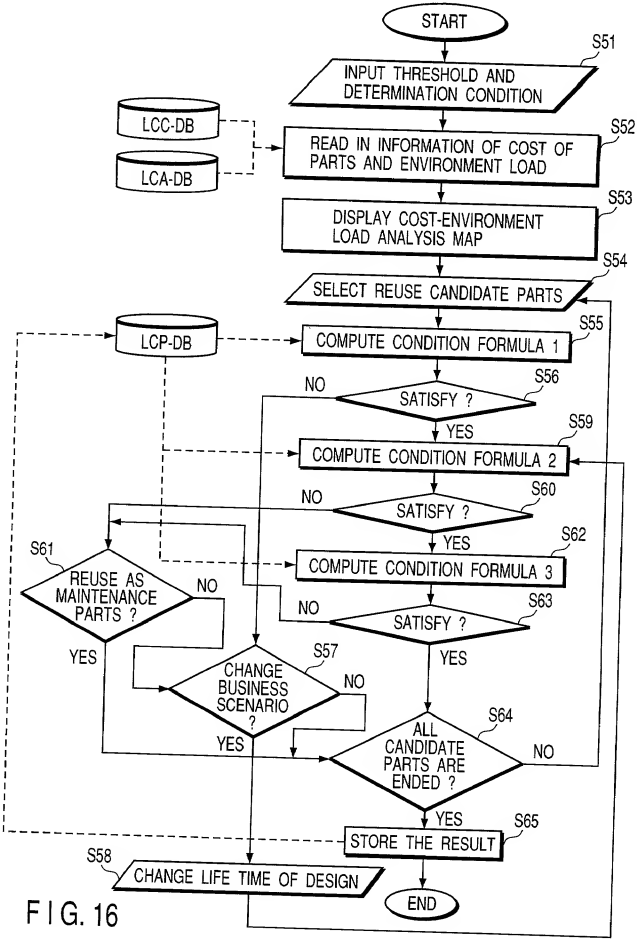
START
S51
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCA-DB
S52
READ IN INFORMATION OF COST OF PARTS AND ENVIRONMENT LOAD
S53
DISPLAY COST-ENVIRONMENT LOAD ANALYSIS MAP
S54
SELECT REUSE CANDIDATE PARTS
LCP-DB
S55
COMPUTE CONDITION FORMULA 1
NO
S56
SATISFY ?
YES
S59
COMPUTE CONDITION FORMULA 2
NO
S60
SATISFY ?
YES
S62
COMPUTE CONDITION FORMULA 3
S61
REUSE AS MAINTENANCE PARTS ?
NO
NO
S63
SATISFY ?
YES
YES
S57
CHANGE BUSINESS SCENARIO ?
NO
YES
S64
ALL CANDIDATE PARTS ARE ENDED ?
NO
YES
S65
STORE THE RESULT
S58
CHANGE LIFE TIME OF DESIGN
END

FIG. 16

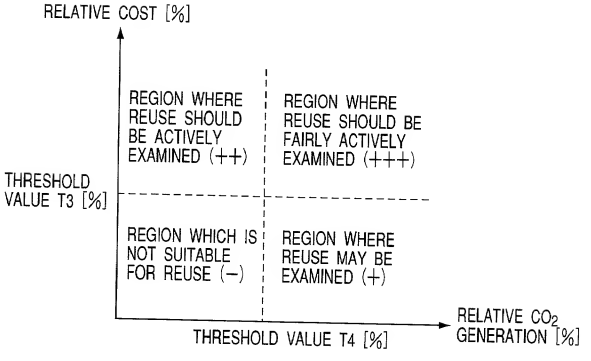
RELATIVE COST [%]
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
THRESHOLD VALUE T3 [%]
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
REGION WHERE REUSE MAY BE EXAMINED (+)
RELATIVE CO_2 GENERATION [%]
THRESHOLD VALUE T4 [%]

FIG. 17

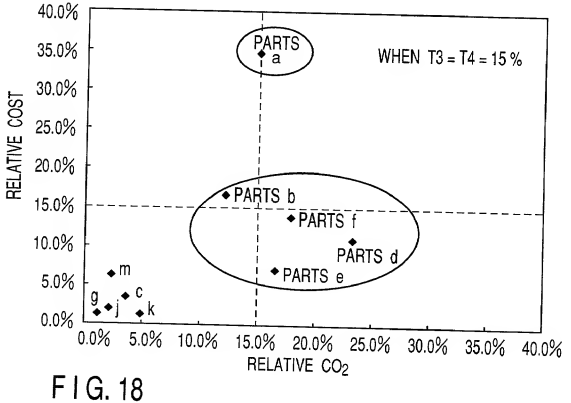
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
RELATIVE COST
PARTS a
WHEN T3 = T4 = 15 %
PARTS b
PARTS f
PARTS d
PARTS e
m
g
j
c
k
0.0% 5.0% 10.0% 15.0% 20.0% 25.0% 30.0% 35.0% 40.0%
RELATIVE CO_2

FIG. 18

- CONDITION FORMULA 1 : THE SIDE OF USEFUL LIFE

$$\min\{ {}^{i}la, {}^{i}lr \} \leq {}^{j}la - \min\{ {}^{i}la, {}^{i}lr \}$$

WHERE ${}^{i}l$ IS LIFE TIME OF PRODUCT, ${}^{j}l$ IS LIFE TIME OF PARTS

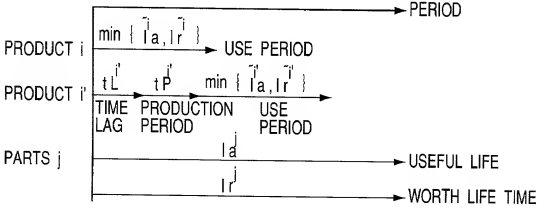

FIG. 19

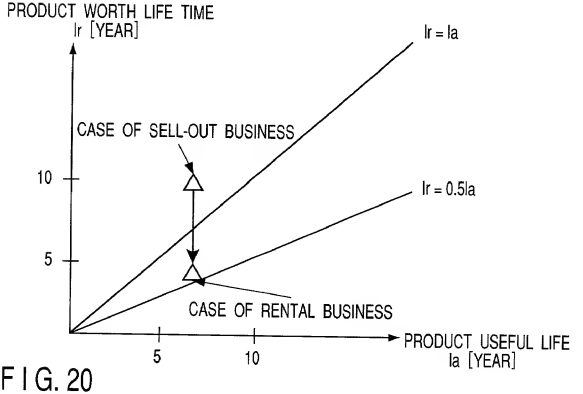

FIG. 20

- CONDITION FORMULA 2 : THE SIDE OF WORTH LIFE TIME

$$tL^{i'} + tP^{i'} + \min\{ {}^{i}la, {}^{i}lr^{i'} \} \leq lr^{j}$$

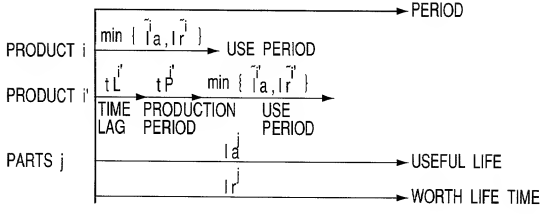

FIG. 21

- CONDITION FORMULA 3 : THE SIDE OF RECOVERY QUANTITY

$$\min\{ {}^{i}la, {}^{i}lr^{i} \} < tL^{i'} + \alpha\, tP^{i'}$$

WHERE $0 \leq \alpha \leq 1$ α : PERIOD FACTOR

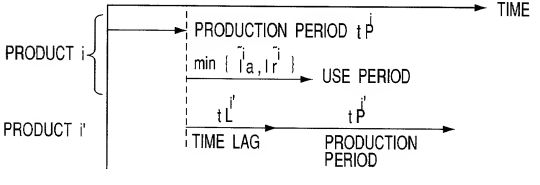

FIG. 22

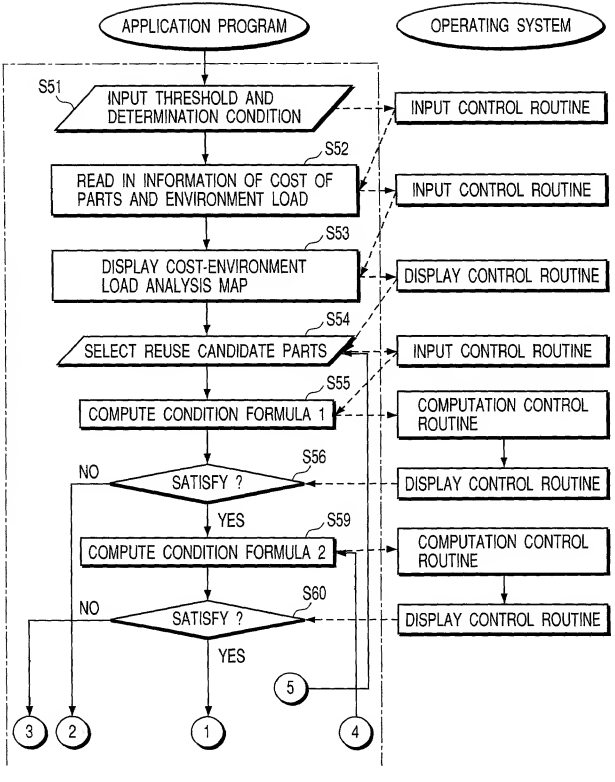
APPLICATION PROGRAM
OPERATING SYSTEM
S51
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S52
READ IN INFORMATION OF COST OF PARTS AND ENVIRONMENT LOAD
INPUT CONTROL ROUTINE
S53
DISPLAY COST-ENVIRONMENT LOAD ANALYSIS MAP
DISPLAY CONTROL ROUTINE
S54
SELECT REUSE CANDIDATE PARTS
INPUT CONTROL ROUTINE
S55
COMPUTE CONDITION FORMULA 1
COMPUTATION CONTROL ROUTINE
NO
S56
SATISFY ?
DISPLAY CONTROL ROUTINE
YES
S59
COMPUTE CONDITION FORMULA 2
COMPUTATION CONTROL ROUTINE
NO
S60
SATISFY ?
DISPLAY CONTROL ROUTINE
YES
5
3
2
1
4

FIG. 23A

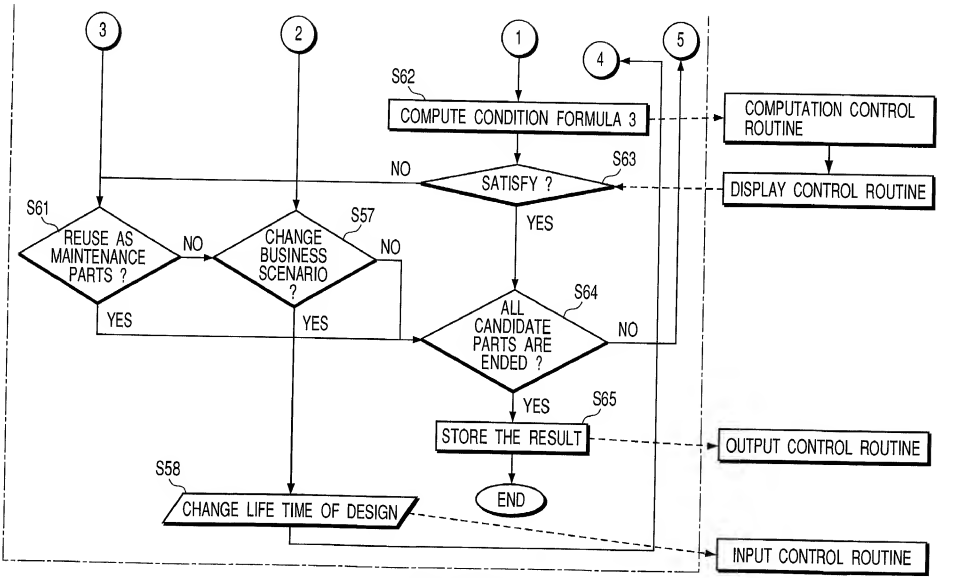

FIG. 23B

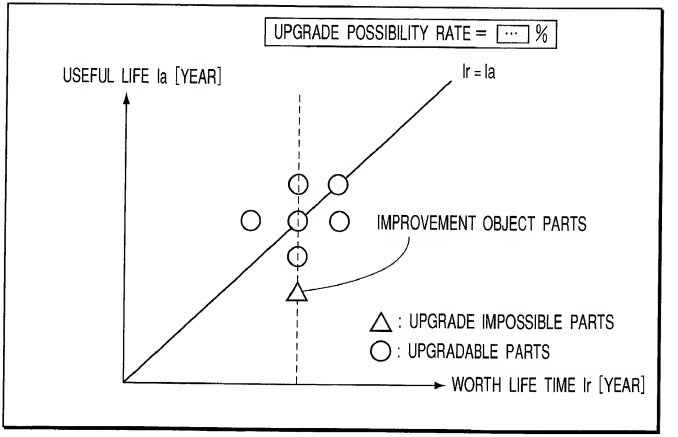

FIG. 24

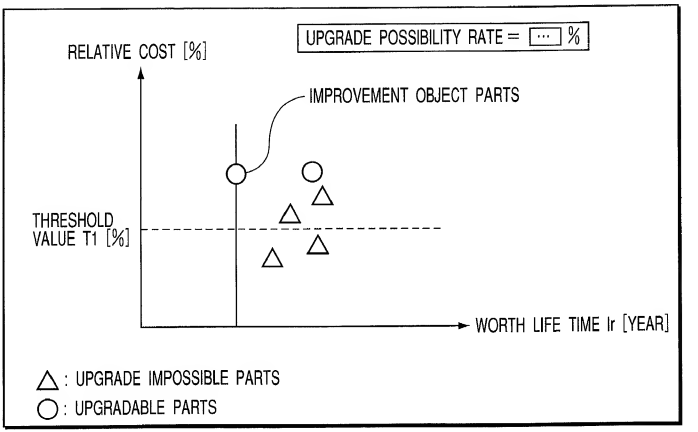

FIG. 25

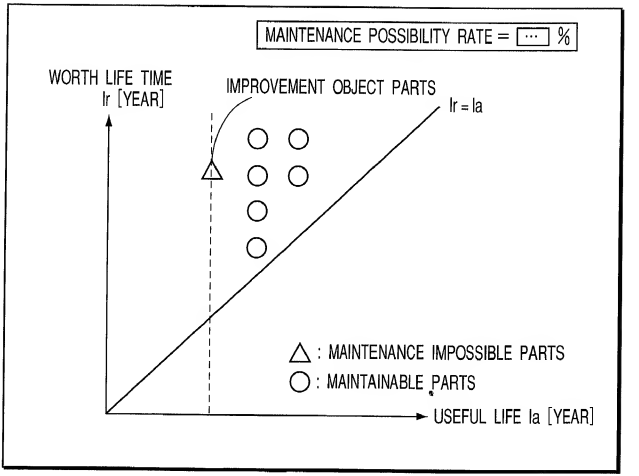

FIG. 26

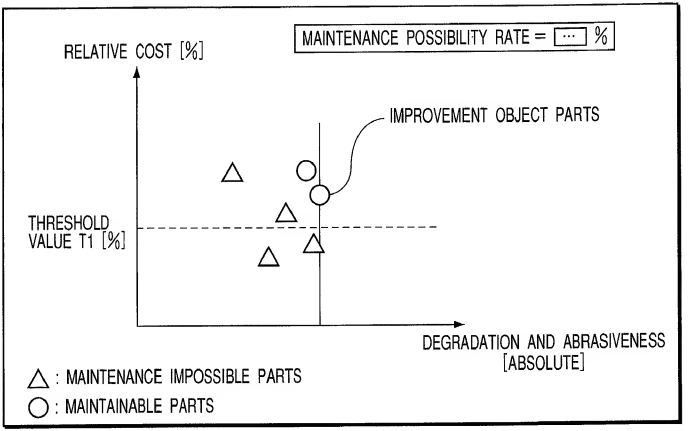

FIG. 27

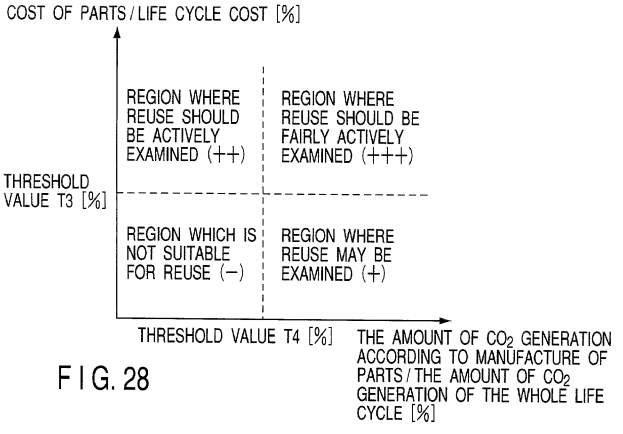
COST OF PARTS / LIFE CYCLE COST [%]
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
THRESHOLD VALUE T3 [%]
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
REGION WHERE REUSE MAY BE EXAMINED (+)
THRESHOLD VALUE T4 [%]
THE AMOUNT OF CO_2 GENERATION ACCORDING TO MANUFACTURE OF PARTS / THE AMOUNT OF CO_2 GENERATION OF THE WHOLE LIFE CYCLE [%]

FIG. 28

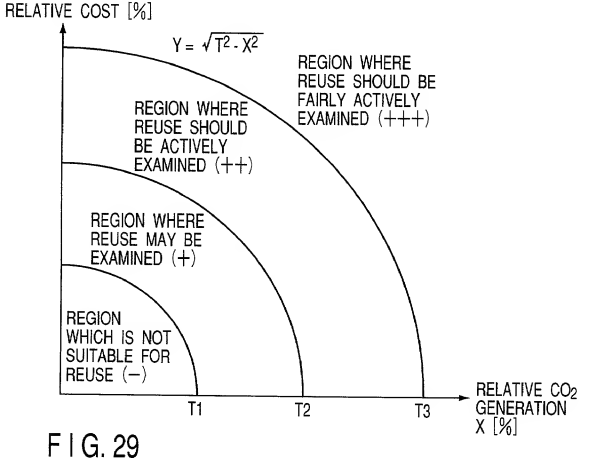
RELATIVE COST [%]
$Y = \sqrt{T^2 - X^2}$
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE MAY BE EXAMINED (+)
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
T1
T2
T3
RELATIVE CO_2 GENERATION X [%]

FIG. 29